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EFFECTS OF A-RATION MEALS ON BODY WEIGHT DURING SUSTAINED FIELD OPERATIONS

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Army rations are designed to provide enough energy and other nutrients to meet the nutritional demands and requirements of soldiers in the field. In spite of the availability of sufficient calories, body weight loss has been reported frequently during field studies especially when troops are required to subsist solely on packaged rations such as the Meal, Ready-To-Eat (MRE). The body weight loss has been attributed to inadequate consumption of the rations. Food consumption and body weight data were collected from 31 soldiers in three artillery batteries involved in 8 days of sustained operations field exercises. Because of a temporary moratorium on the use of MREs, the soldiers were fed 3 hot A-ration meals/day during the exercise. The soldiers consumed an average of 3713 kcal/day to produce an overall body weight gain of 0.8 kg during the 8 days of sustained operations. Comparing the results of the present study with that of recent field studies indicated that soldiers consume more calories and lose less body weight when served 3 hot A-ration meals/day as opposed to 2 A-rations/1 MRE, 2 B-rations/1 MRE, 2 T-rations/1 MRE, 1 T-ration/2 MREs, or

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3 MREs per day. These data clearly indicate that soldiers served hot meals that they like and given the time to eat these meals will consume sufficient calories to maintain energy balance even during sustained, physically demanding field exercises. Keywords:

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Human subjects participated in these studies after giving their free and informed voluntary consent. Investigators adhered to AR 70-25 and USAMRDC Regulation 70-25 on Use of Volunteers in Research.

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EFFECTS OF A-RATION MEALS
ON BODY WEIGHT
DURING SUSTAINED FIELD OPERATIONS

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FOREWORD

The data for this report were obtained during a study of sustained operations conducted by the Army Physical Fitness Research Institute of the U. S. Army War College and the U. S. Army Research Institute of Environmental Medicine (USARIEM) from 28 May to 5 June 1986 at Fort Sill, Oklahoma. Other aspects of the overall effort will be published in other reports by the Army Physical Fitness Research Institute and by the Exercise Physiology Division of USARIEM.

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ABSTRACT

Army rations are designed to provide enough energy and other nutrients to meet the nutritional demands and requirements of soldiers in the field. In spite of the availability of sufficient calories, body weight loss has been reported frequently during field studies especially when troops are required to subsist solely on packaged rations such as the Meal, Ready-To-Eat (MRE). The body weight loss has been attributed to inadequate consumption of the rations. Food consumption and body weight data were collected from 31 soldiers in three artillery batteries involved in 8 days of sustained operations field exercises. Because of a temporary moratorium on the use of MREs, the soldiers were fed 3 hot A-ration meals/day during the exercise. The soldiers consumed an average of 3713 kcal/day to produce an overall body weight gain of 0.8 kg during the 8 days of sustained operations. Comparing the results of the present study with that of recent field studies indicated that soldiers consume more calories and lose less body weight when served 3 hot A-ration meals/day as opposed to 2 A-rations/1 MRE, 2 B-rations/ 1 MRE, 2 T-rations/1MRE, 1 T-ration/2MREs, or 3 MREs per day. These data clearly indicate that soldiers served hot meals that they like and given the time to eat these meals will consume sufficient calories to maintain energy balance even during sustained, physically demanding field exercises.

INTRODUCTION

Feeding soldiers in the field poses many logistical problems. Setting up and moving field kitchens, obtaining fresh foods, refrigerating perishable foods, and preventing food poisoning and contamination are some of the problems of feeding an army in the field. New combat field feeding systems utilizing the Meal, Ready-To-Eat (MRE) and Tray Pack Rations (T-rations) are being developed in an effort to simplify feeding procedures, to reduce the number of cooks, and/or to solve the logistical problems. If rations are prepackaged and only need to be heated, opened, and served, then experienced cooks are not needed and significant manpower savings can be achieved. However, to be fully effective, combat rations must provide nutritionally balanced, wholesome, and appetizing meals that will be consumed in sufficient quantities to meet the nutritional demands of the soldier in the field.

The loss of body weight by soldiers in the field has been reported during recent ration trials (1,2) as well as during the extensive feeding trials conducted during World War II (3). Reasons that have been proposed to explain the weight loss are: deliberate dieting in the field; loss of appetite; dehydration; unacceptability of the pre-prepared rations, etc. (1,2). In previous field feeding studies, weight loss has occurred even when various combinations of rations (A, B, T, MRE) were fed (1,2). This has led some to assume that weight loss is inevitable in the field, regardless of what ration is offered.

During the 1985 Combat Field Feeding System-Force Development Test and Experimentation (CFFS-FDTE) (1) study, average body weight losses never exceeded 3% of initial body weight during the 44-day study, but individual weight losses of 5.0 and 7.5% were observed among some soldiers eating all types of rations. Less than 10% of the soldiers eating 2 A-rations/1 MRE/day had body weight losses greater than 5% whereas up to 40% of those eating 2 B-rations/1 MRE/day had body weight losses greater than 5% (1). The energy intake of soldiers eating 3 MREs/day was 2445 kilocalories (kcal) and did not meet the lower limit of the Military Recommended Dietary Allowances (MRDA) energy requirement range (2800-3600 kcal/day) for moderately active military personnel (Table 1). The soldiers who were eating 2 A-rations/1 MRE/day consumed 3271 kcal/day (Table 2) to meet the MRDA for energy but the soldiers still lost a modest amount of body weight. The soldiers consumed more calories when eating 2 A-rations/1 MRE than for any other combination of rations.

The results of the CFFS-FDTE (1) study supported the findings of Hirsch et al. (2) who reported that the acceptability of MREs (based on hedonic ratings) was high but actual consumption of MREs ranged from a high of 68% for entrees to a low of 26% for condiments and candies. The soldiers consumed 2189 kcal/day when fed 3 MREs/day for 34 consecutive days compared to 2950 kcal/day when fed 2 A-rations/1 MRE/day. As in the CFFS-FDTE (1) study, these soldiers ate more when fed A-rations. Consumption of MREs in the Hirsch et al. (2) study was lower than in the CFFS-FDTE (1) study when MREs were fed as the sole subsistence for 3 consecutive days. Over the 34 days of the Hirsch et al. (2) test, the daily caloric intake of soldiers eating 3 MREs/day declined. The dietary intakes of those soldiers eating 2 A-rations/1 MRE/day remained stable. In the Hirsch et al. (2) study the troops fed 3 MREs/day lost 3.4% of their initial body weight by the 12th day and 5.8% by the 34th day while the group eating 2 A-rations/1 MRE lost only

TABLE 1

MRDA for selected nutrients [1]

Nutrient	Unit	Male	Female
Energy [2,3]	kcal MJ	3200(2800-3600) 13.4(11.7-15.1)	2400(2000-2800) 10.0(8.4-11.7)
Protein [4]	gm	100	80
Vitamin A [5]	mcg RE	1000	800
Vitamin D [6,7]	mcg	5-10	5-10
Vitamin E [8]	mg TE	10	8
Ascorbic Acid	mg	60	60
Thiamin (B_1)	mg	1.6	1.2
Riboflavin (B_2)	mg	1.9	1.4
Niacin [9]	mg NE	21	16
Vitamin B_6	mg	2.2	2.0
Folacin	mcg	400	400
Vitamin B_{12}	mcg	3.0	3.0
Calcium [7]	mg	800-1200	800-1200
Phosphorus [7]	mg	800-1200	800-1200
Magnesium [7]	mg	350-400	300
Iron [7]	mg	10-18	18
Zinc	mg	15	15
Iodine	mcg	150	150
Sodium	mg	See note [10]	See note [10]

[1] MRDA for moderately active military personnel, ages 17 to 50 years, are based on the *Recommended Dietary Allowances*, ninth revised edition, 1980.
[2] Energy allowance ranges are estimated to reflect the requirements of 70 percent of the moderately active military population. One megajoule (MJ) equals 239 kcals.
[3] Dietary fat calories should not contribute more than 35 percent of total energy intake.
[4] Protein allowance is based on an estimated protein requirement of 0.8 gm/kilogram (kg) desirable body weight. Using the reference body weight ranges for males of 60 to 79 kilograms and for females of 46 to 63 kilograms, the protein requirement is approximately 48 to 64 grams for males and 37 to 51 grams for females. These amounts have been approximately doubled to reflect the usual protein consumption levels of Americans and to enhance diet acceptability.
[5] One microgram of retinol equivalent (mcg RE) equals 1 microgram of retinol, or 6 micrograms betacarotene, or 5 international units (IU).
[6] As cholecalciferol, 10 micrograms of cholecalciferol equals 400 IU of vitamin D.
[7] High values reflect greater vitamin D, calcium, phosphorus, magnesium, and iron requirements for 17- to 18-year olds than for older ages.
[8] One milligram of alpha-tocopherol equivalent (mg TE) equals 1 milligram d-alpha-tocopherol.
[9] One milligram of niacin equivalent (mg NE) equals 1 milligram niacin or 60 milligrams dietary tryptophan.
[10] The safe and adequate levels for daily sodium intake of 1100 to 3300 mg published in the RDA are currently impractical and unattainable within military food service systems. However, an average of 1700 milligrams of sodium per 1000 kilocalories of food served is the target for military food service systems. This level equates to a daily sodium intake of approximately 5500 milligrams for males and 4100 milligrams for females.

TABLE 2

CALORIC INTAKE[a] OF RECENT RATION STUDIES

RATION TYPE	RATION STUDIES	
	HIRSCH et al. (2)[b]	CFFS-FDTE(1)
3 MREs	2189	2445[c]
1 T-ration/2 MREs	-	2660[d]
2 T-rations/1 MRE	-	2725[d]
2 B-rations/1 MRE	-	2760[d]
2 A-rations/1 MRE	2950	3271[d]

[a]kcal/day
[b]See reference (2)
[c]See reference (1), Table 1-6
[d]See reference (1), Table 2-32

1.2% after 12 days and 2.6% after 34 days. By the 34th day 15% of the group eating 3 MREs had lost more than 10% of initial body weight (Hirsch personal communication) whereas none of the soldiers in the 2 A-rations/1 MRE group had lost that much body weight.

Combat operations in which the fighting continues for 24 hours or longer are defined as sustained operations (4). Soldiers participating in sustained operations should have higher energy requirements because they are active for a longer portion of a 24 hour period. They are allowed short periods of unscheduled sleep whereas soldiers in normal operations are scheduled an 8-10 hour sleep period at night. There are very few studies on sustained operations that have reported energy intake and body weight data. There is essentially no data available on whether increasing physical activity will increase the consumption of field rations or increase the extent of body weight loss. Rognum et al. (5) cited the work of Christensen and Hansen (6) who were the first to show that a high carbohydrate diet improved endurance during sustained, heavy exercise (3.5 hours of treadmill running). In a study by Legg (7), 8 days of sustained operations caused weight loss that averaged 1.1%. In a 5 day sustained operations study (8), infantry soldiers lost a mean of 1.82% body weight (Vogel personal communication). About 21.2% of these soldiers lost greater than 3% body weight and 3.03% lost greater than 5% body weight. Rognum et al. (5) reported that subjects in a 107 hour heavy exercise study lost 0.8% body weight when offered a 8000 kcal/day diet whereas the subjects that were on a 1500 kcal/day diet lost 4.63% of their body weight. The actual number of calories ingested by subjects on the 8000 and 1500 kcal diets were not available.

Some studies have provided reasons to explain why energy requirements are not increased during sustained exercises. Rognum et al. (5) cited the study by Waldum and Huser (9) that showed that soldiers may not be losing weight because in simulated combat they restrict their hard work (exceed 50% VO_2 max) to short periods. When allowed to select their own work rate, soldiers work at less than 40% VO_2 max (10-12) to prevent fatigue. Therefore, the physical activity level for soldiers in a sustained operations exercise may be categorized as moderate rather than heavy.

In well-fed and rested persons, muscle glycogen is available for moderately intense exercise (60-80% VO_2 max) for up to 2 hours (13). During exercise, tissue triglyceride levels decrease by approximately 10-15% whereas muscle glycogen levels decrease by 70% for the same time period (14) indicating that carbohydrate stores may be the limiting factor during prolonged physical activity (14,15). Ahlborg et al. (16) have shown a good correlation between performance time and muscle glycogen decrease. The concentration of muscle glycogen is related to performance time to exhaustion only when work levels are 40% VO_2 max or higher (15,17,18). Low intensity exercise (ie. 30-50% VO_2 max) relies mainly upon fat for fuel and muscle glycogen is consumed at a slow rate taking 5-10 hours of continuous activity to deplete muscle glycogen (13,19).

Researchers (16,20) have observed that after muscle glycogen stores had been depleted by exercise, a high carbohydrate diet enhanced the synthesis of muscle glycogen and therefore increased the performance time to exhaustion (21-23). Hultman and Bergstrom (20) showed that when carbohydrate is given without any previous exercise, there is only a moderate increase in muscle glycogen stores. Since performance time during moderate exercise depends on muscle glycogen stores, replenishing muscle glycogen stores during sustained operations would be important in maintaining the performance of the soldier.

The purpose of this study was to determine if consumption of 3 A-ration meals/day would be adequate to maintain body weight in soldiers undergoing an 8-day sustained operations field exercise.

METHOD

The dietary and weight data were collected as part of a larger study on the effects of physical fitness on 3 field artillery batteries involved in 8 days of sustained operations field exercises. The study was conducted at Fort Sill, OK from 28 May to 5 June 1986. The weather conditions during the test were temperate as noted in Appendix A. Sleep averaged about 5-6 hours/day and was obtained during lulls in activity. Each battery was assigned one dietary data collector who was responsible for collecting daily food consumption, body weight, and fluid intake data from 12 subjects who volunteered to provide the requested data. In each battery, data were collected from 8 soldiers manning the base gun and from 4 soldiers on the flank pieces. Due to accidents and missing data, the final data were based on 21 soldiers from the base guns (7 from each battery) and on 10 soldiers from the flank guns. The physical characteristics of the test subjects are described in Table 3.

The soldiers were supposed to eat 3 MREs/day during the 8-day exercise to simulate actual combat feeding. But, they were fed 3 A-ration meals/day because of a Headquarters Department of the Army temporary moratorium on the use of MREs which occurred 3 days prior to the start of this field exercise. Hot A-ration meals were prepared in the garrison dining facility three times a day. Each study day started with the lunch meal and ended with breakfast the following day. The menus are provided in Appendix B. The food preparation in the garrison kitchen was monitored. Ingredients for recipes were weighed and deviations from recipes were noted to increase the accuracy of the nutrient composition data base. The cooks used recipes from the Armed

TABLE 3

PHYSICAL CHARACTERISTICS

	BATTERIES			
	A	B	C	MEAN
n	11	9	11	31
Age (years)	21 ± 3.1[a]	22 ± 4.1	23 ± 3.4	22 ± 3.4
Height (cm)	176.2 ± 5.4	173.7 ± 4.8	175.2 ± 6.8	175.1 ± 5.7
Weight (kg)	82.8 ± 15.2	80.6 ± 8.0	77.4 ± 10.1	80.2 ± 11.5

[a]Mean±SD

Forces Recipe file (1981 version). The prepared foods were packed in mermite insulated food servers, trucked to the field feeding site (30-60 min), and served to the soldiers in the field. The data collector went out with the food trucks three meals a day (0530, 1100, and 1700 hours). Meal service was available for 1-2 hours to allow all soldiers sufficient time to obtain their food. Soldiers were rotated through the firing gun positions during meal periods to ensure that all soldiers were given an opportunity to eat. Food was served at 2 different sites during a meal period if the battery was ordered to move in the middle of meal service or if members of that battery were in a different location during the meal period.

Data collectors used a direct observation method to gather food consumption data without interfering with the sustained operations exercise or delaying meal service. The data collectors had been trained to estimate portion size (nearest 0.1 portion). At each meal the data collectors carried pre-weighed standard portions of foods to the field. They compared the portions that were served and the waste that was returned to the pre-weighed standard portions. This direct observation technique was similar to that developed and validated during the CFFS-FDTE (1) study. In that study, it was demonstrated that experienced data collectors could estimate average portion sizes with an error of approximately ± 2 percent. Data were recorded on manual data collection forms (Appendix C) in the field and then entered into personal computers in garrison facilities. The food consumption data were coded, entered into computer files, checked for errors, and rechecked by the data collectors for interpretation errors. The food consumption data were analyzed on the VAX 780 computer. The nutrient data file to analyze the food consumption data was created from the University of Massachusetts Nutrient Data Bank and USDA food composition tables utilizing the Armed Forces recipes as modified by the cooks during this study.

Fluid intake data were collected by personal interview. The soldiers were questioned at each meal as to the fluid that they had consumed since the previous meal. They were asked to report the number of quart canteens or fractions of canteens that they had consumed since the previous meal. The data were analyzed to obtain values for fluid from food, fluid drunk at meals, and fluid drunk from canteens.

Each soldier was weighed daily using Seca Alpha 770 battery operated digital scales. Each day the dietary data collector calibrated the scales with 100 lb weights in the garrison kitchen, weighed himself on the scale in the garrison kitchen, carried the scale to the field, and weighed himself again in the field to be sure that the scale was stabilized on the plywood board. The soldiers were weighed in undershirts, pants, and boots. They were asked to remove their web gear, helmet, and outside shirt. Once the soldiers had moved to the field and were ready to start the exercise, the three data collectors obtained pre-exercise body weights. On succeeding days the soldiers were weighed in the morning before breakfast.

Pre- and post-exercise body weights were obtained from extra soldiers in each battery who were not part of the study. The body weights of these other subjects were obtained to check if daily monitoring of the subjects in the study would affect their weights so the data would not be representative of all the soldiers in the battery.

Analysis of Variance tests were used to determine whether the batteries were significantly different. The Student-Newman-Keuls post hoc test was used in determining which groups were significantly different.

RESULTS

The nutrient intake from the consumption of three A-ration meals/day exceeded the MRDA (Table 1) for energy, protein, and all minerals for each of the three batteries (Table 4) and for the combination of all batteries (Table 5). Soldiers were able to consume more than 100% of the MRDA for all vitamins except vitamin B_6 and folacin (Table 6). The values for the vitamin B_6 and folacin content of the diet may be underestimated due to missing data in the nutrient data file and therefore the moderately low values should not be interpreted to mean that the vitamin B_6 and folacin intakes were inadequate or deficient. Although there were MRDA for vitamin D, vitamin E, and iodine, information on these nutrients was lacking or incomplete in the nutrient data file and therefore intakes of these nutrients were not reported.

The average energy intake was 3973, 3467, and 3654 kcal/day for batteries A, B, and C, respectively, with an overall average of 3713 kcal/day (Table 7) for all 3 batteries. Daily energy intake values are in Appendix D. Battery A consumed significantly ($p < 0.001$) more calories than batteries B and C. However, when energy intake was calculated as kcal/kg body weight (BW), the values for the three batteries did not differ statistically (Table 8).

The energy intake values were significantly different ($p < 0.01$) between the soldiers at the base and flank gun positions (Table 9). When comparing the energy intake values of soldiers in the base and flank positions, the soldiers in batteries B and C were not consuming significantly different amounts of calories. However the base soldiers in battery A were consuming

TABLE 4

NUTRIENT INTAKE DURING 8 DAYS OF SUSTAINED FIELD OPERATIONS

NUTRIENTS	BATTERY A (n=11)	BATTERY B (n=9)	BATTERY C (n=11)
Energy (Kcal)	3973±975[a]	3467±643	3654±583
Protein (g)	134±34	126±25	127±23
Total Fat (g)	165±49	147±32	141±30
% of Calories	37.4	38.1	34.6
Saturated Fat (g)	56.0±17	50.3±12	47.3±11
Monounsat Fat (g)	62.0±22	55.1±14	52.8±13
Polyunsat Fat (g)	25.6±8.6	23.1±8.3	21.9±7.3
Cholesterol (mg)	778±241	744±121	725±142
Carbohydrate (g)	496±129	417±85	478±81
Vitamin A (mcg RE)	2071±1625	2566±2276	2344±1939
Vitamin C (mg)	146±72	215±159	208±174
Thiamin (mg)	2.84±0.9	2.91±0.9	2.67±0.8
Riboflavin (mg)	3.00±1.0	3.35±1.2	3.23±0.8
Niacin (mg NE)	29.5±7.2	29.0±8.6	31.9±15
Vitamin B_6 (mg)	1.75±0.4	2.06±1.1	1.91±0.7
Folacin (mcg)	365±96	416±132	406±144
Vitamin B_{12} (mcg)	5.53±2.4	6.75±3.7	6.25±2.2
Calcium (mg)	1411±614	1535±590	1568±443
Phosphorus (mg)	2105±643	2096±565	2160±439
Magnesium (mg)	410±116	398±107	431±146
Iron (mg)	25.0±5.5	25.0±8.7	24.2±7.8
Zinc (mg)	16.5±4.7	16.7±5.9	16.7±5.4
Sodium (mg)	8431±2640	7317±2512	6551±2036
Sodium (mg/1000 kcal)	2122	2111	1793
Potassium (mg)	4473±1058	4366±1041	4402±901

[a]Mean±SD

TABLE 5

NUTRIENT INTAKE FOR ALL SUBJECTS
DURING 8 DAYS OF SUSTAINED FIELD OPERATIONS

NUTRIENTS	MEAN ± SD
Energy (Kcal)	3713 ± 785
Protein (g)	129 ± 28
Total Fat (g)	151 ± 40
% of Calories	36.6
Saturated Fat (g)	51.3 ± 14
Monounsat Fat (g)	56.7 ± 17
Polyunsat Fat (g)	23.6 ± 8.2
Cholesterol (mg)	749 ± 180
Carbohydrate (g)	467 ± 107
Vitamin A (mcg RE)	2311 ± 1945
Vitamin C (mg)	188 ± 144
Thiamin (mg)	2.80 ± 0.9
Riboflavin (mg)	3.18 ± 1.0
Niacin (mg NE)	30.2 ± 11
Vitamin B_6 (mg)	1.90 ± 0.8
Folacin (mcg)	394 ± 127
Vitamin B_{12} (mcg)	6.14 ± 2.8
Calcium (mg)	1503 ± 554
Phosphorus (mg)	2122 ± 553
Magnesium (mg)	414 ± 125
Iron (mg)	24.7 ± 7.3
Zinc (mg)	16.6 ± 5.3
Sodium (mg)	7441 ± 2523
Sodium (mg/1000 Kcal)	2004
Potassium (mg)	4417 ± 997

TABLE 6

PERCENTAGE OF MRDA OF NUTRIENTS CONSUMED
DURING 8 DAYS OF SUSTAINED FIELD OPERATIONS

NUTRIENTS	BATTERY			
	A	B	C	MEAN
Energy	124.2 ± 30.5	108.3 ± 20.1	114.2 ± 18.2	116.0 ± 24.5
Protein	133.7 ± 33.9	126.3 ± 25.2	126.7 ± 22.5	129.0 ± 27.9
Vitamin A	207.1 ±162.5	256.6 ±227.6	234.4 ±193.9	231.1 ±194.5
Vitamin C	244.0 ±119.5	358.2 ±264.1	347.4 ±290.2	313.9 ±239.7
Thiamin	176.8 ± 58.0	181.5 ± 56.2	167.0 ± 50.4	174.7 ± 55.0
Riboflavin	157.7 ± 52.6	176.5 ± 64.9	169.6 ± 44.0	167.4 ± 54.1
Niacin	140.4 ± 34.1	138.0 ± 41.1	151.8 ± 72.4	143.7 ± 52.7
Vitamin B_6	79.4 ± 17.6	93.5 ± 48.2	86.8 ± 32.7	86.1 ± 34.5
Folacin	91.2 ± 24.0	103.9 ± 32.9	101.5 ± 36.1	98.5 ± 31.7
Vitamin B_{12}	184.2 ± 78.3	225.2 ±123.6	208.4 ± 72.4	204.7 ± 93.2
Iron	249.9 ± 54.8	250.1 ± 86.7	242.5 ± 77.8	247.3 ± 73.2
Calcium	176.4 ± 76.8	191.9 ± 73.7	196.0 ± 55.4	187.8 ± 69.2
Phosphorus	263.1 ± 80.4	262.1 ± 70.6	270.0 ± 54.8	265.2 ± 69.1
Magnesium	117.1 ± 33.1	113.8 ± 30.6	123.3 ± 41.7	118.3 ± 35.8
Zinc	109.8 ± 31.1	111.5 ± 39.5	111.0 ± 35.9	110.7 ± 35.3
Sodium	153.3 ± 48.0	133.0 ± 45.7	119.1 ± 37.0	135.3 ± 45.9

TABLE 7

ENERGY INTAKE (KCAL) DURING 8 DAYS OF SUSTAINED FIELD OPERATIONS

	n	Mean	SD
Battery A	11	3973^a	975
Battery B	9	3467^b	643
Battery C	11	3654^b	583
Mean	31	3713	785

Superscript a is significantly different from superscript b, $p < 0.001$

TABLE 8

ENERGY INTAKE PER UNIT BODY WEIGHT DURING
8 DAYS OF SUSTAINED FIELD OPERATIONS

DAY	BATTERY A	B	C	MEAN
1	39.05[a]	-[b]	42.53	40.79
2	51.80	43.40	48.94	48.34
3	48.09	45.62	47.14	47.03
4	37.09	34.70	40.34	37.55
5	53.80	40.59	50.32	48.73
6	47.10	46.51	50.82	48.25
7	-	46.80	-	46.80
8	51.52	52.58	50.60	51.50
Mean	46.92	44.31	47.24	46.28
SD	9.98	9.80	9.23	9.71

[a]Kcal/Kg Body Weight
[b]Missing data

TABLE 9

COMPARISON OF ENERGY INTAKE (KCAL)
OF SOLDIERS AT DIFFERENT GUN POSITIONS
DURING 8 DAYS OF SUSTAINED FIELD OPERATIONS

	GUN POSITION		
	BASE	FLANK	p
Battery A	4200 ± 1058[a] (n=7)[b]	3577 ± 653 (n=4)	0.006
Battery B	3501 ± 671 (n=7)	3346 ± 537 (n=2)	NS
Battery C	3717 ± 574 (n=7)	3540 ± 589 (n=4)	NS
Mean	3806 ± 843 (n=21)	3516 ± 605 (n=10)	0.003

[a]Mean$\pm$SD

[b]Number of Subjects

significantly more calories than the corresponding soldiers on the flank guns of that battery. The number of calories consumed by the base soldiers in battery A was enough to influence the difference in calories consumed between base and flank when all soldiers were considered.

Consumption of fat for all soldiers (Table 5) exceeded the levels recommended in the MRDA (Table 1). In the present study 37.4, 38.1, and 34.6% of the calories for batteries A, B, and C, respectively, were derived from fat (Table 10). However, separating the fat values into what was served and what was added by the soldier showed that the dining facility was serving food that nearly met the recommendations for these nutrients. The food as prepared by the cooks provided 35.0, 36.5, and 33.7% of the total calories as fat for batteries A to C. When the soldiers added extra butter to their food, the intake values exceeded desired levels.

Total daily sodium intake (Table 11) exceeded the levels recommended in the MRDA (Table 1) and clarified by a letter from the Office of the Surgeon General (OTSG) to the Deputy Chief of Staff of Logistics (DCSLOG) (Appendix F). Sodium guidelines were set as 1400-1700 mg/1000 kcal. The salt from 1 gm packets that the soldiers in batteries A, B, and C added to their food contributed 19.9, 17.0, and 9.1% of the total sodium in their diet. If the added salt had been excluded, the soldiers would have consumed 1700, 1752, and 1630 mg sodium/1000 kcal. The dining facility was serving food that met the recommendations for sodium. When the soldiers added extra salt to their food, the intake values exceeded desired levels.

To determine if being a test subject affected the body weight change and presumably the energy intake and expenditure of the soldiers in the study, other soldiers in the batteries were weighed. Weight change was not

TABLE 10

DIETARY SOURCES OF FAT
DURING 8 DAYS OF SUSTAINED FIELD OPERATIONS

		BATTERY		
		A	B	C
Fat from Butter	(g)	9.8$\pm$14.1[a]	6.0$\pm$13.1	3.9$\pm$5.7
	(%)	(2.2)[b]	(1.6)	(0.9)
Fat from Food	(g)	155.2$\pm$49.4	140.7$\pm$30.8	136.8$\pm$29.8
	(%)	(35.0)	(36.5)	(33.7)
Total Fat	(g)	165.0$\pm$48.5	146.7$\pm$32.4	140.7$\pm$30.2
	(%)	(37.4)	(38.1)	(34.6)

[a]Mean $\pm$ SD

[b]Percent(%) of Total Fat Calories

TABLE 11

DIETARY SOURCES OF SODIUM
DURING 8 DAYS OF SUSTAINED FIELD OPERATIONS

	BATTERY		
	A	B	C
Sodium from Salt[a] (mg/day)	1678.1$\pm$1123.8[b]	1243.7$\pm$1414.7	594.6$\pm$848.4
(%)	(19.9)[c]	(17.0)	(9.1)
(mg/1000 Kcal)	422	359	163
Sodium from Food (mg/day)	6753.4$\pm$2271.4	6073.3$\pm$2052.7	5956.2$\pm$1896.3
(%)	(80.1)	(83.0)	(90.9)
(mg/1000 Kcal)	1700	1752	1630
Sodium Total (mg/day)	8431.5$\pm$2639.5	7317.0$\pm$2512.3	6550.8$\pm$2035.5
(mg/1000 Kcal)	2122.1	2110.7	1792.8

[a]Salt was available *ad libitum* in 1 gm salt packets.

[b]Mean $\pm$ SD

[c]Percent (%) of Total Sodium

significantly different between the study subjects and the other non-study soldiers (Table 12). The pre-exercise body weights for the soldiers in the different gun positions were not significantly different (Table 13). There was a tendency for the soldiers on the base guns to be heavier than those on the flank guns. The weights were not significantly different between batteries (Table 13). Therefore, the data for the soldiers on the base and flank pieces were combined.

The body weights of the soldiers at the base and flank gun positions were not significantly different between batteries (Table 3). The soldiers in battery A tended to be heavier than those in batteries B and C. The mean weight for soldiers in all three batteries was 80.2 kg.

When fed 3 hot A-ration meals/day, the soldiers were able to consume enough calories to maintain body weight and even to cause an overall weight gain of 0.8 kg during a sustained operations exercise (Table 14). Body weight change (pre- to post-exercise) was significantly different ($p < 0.001$) for the three batteries. The soldiers in batteries A and C gained 1.0 and 1.9 kg, respectively, while the soldiers in battery B lost 0.7 kg of weight. Average changes in body weights compared to pre-test weights did not exceed $\pm 3\%$ (Table 14). Less than 10% of the soldiers in the study lost more than 3% of their initial body weight but none lost more than 5%.

Fluid intake for battery C was significantly greater ($p < 0.001$) than for batteries A and B (Table 15). The amount of fluid from food and from fluid drunk at meals approximated the 5 quarts/day recommended for moderate activity in a temperate environment by the Heat Research Division of USARIEM (Appendix G). The fluid drunk from canteens (1.91 quarts/day) was not significantly different from the fluid drunk at meals (1.72 quarts/day)

TABLE 12

BODY WEIGHT CHANGE (KG) FOR SOLDIERS AT DIFFERENT GUN POSITIONS DURING 8 DAYS OF SUSTAINED FIELD OPERATIONS

	GUN POSITION				
	BASE	FLANK	OTHER	MEAN	p
n	21	10	40	71	
Mean	+0.80	+0.85	+0.32	+0.54	NS
SD	1.86	0.83	1.39	1.49	

(+) Gained Weight

(-) Lost Weight

TABLE 13

COMPARISON OF PRE-EXERCISE BODY WEIGHTS (KG)
BY BATTERY AND GUN POSITION
DURING 8 DAYS OF SUSTAINED FIELD OPERATIONS

	GUN POSITION			
BATTERY	BASE	FLANK	OTHER	p
A	85.9 ± 17.9[a] (7)[b]	77.2 ± 7.6 (4)	77.6 ± 10.8 (17)	NS
B	81.0 ± 9.1 (7)	79.2 ± 0.7 (2)	76.2 ± 8.1 (14)	NS
C	78.7 ± 10.9 (7)	75.1 ± 9.5 (4)	77.8 ± 8.6 (9)	NS
Mean	81.9 ± 12.9 (21)	76.8 ± 7.2 (10)	77.2 ± 9.2 (40)	NS
p	NS	NS	NS	

[a]Mean $\pm$ SD

[b]Number of subjects

TABLE 14

BODY WEIGHT CHANGE (PRE-POST)
DURING 8 DAYS OF SUSTAINED FIELD OPERATIONS

BODY WEIGHT CHANGE	BATTERY			
	A	B	C	MEAN
n	11	9	11	31
(kg)	$+1.0 \pm 1.1^{ab}$	-0.7 ± 1.4^{c}	$+1.9 \pm 1.3^{b}$	$+0.8 \pm 1.6$
(%)	1.1 ± 1.0^{bd}	0.8 ± 1.7^{cd}	2.5 ± 1.7^{be}	1.0 ± 2.0

^{a}Mean$\pm$SD
(+) Weight Gain
(-) Weight Loss

Superscript b is significantly different from superscript c, $p < 0.001$.
Superscript d is significantly different from superscript e, $p < 0.001$.

Table 15

Total Fluid Intake (quarts/day)
During 8 Days of Sustained Field Operations

	Battery		
Day	A	B	C
1	5.00	4.01	5.30
2	4.33	4.31	5.65
3	3.86	4.18	5.49
4	4.28	3.78	5.19
5	4.36	4.30	5.74
6	4.94	5.23	8.19
7	5.65	4.68	6.98
8	3.62	3.41	3.89
Mean	4.50^{a}	4.24^{a}	5.80^{b}
SD	± 1.52	± 1.64	± 2.49

Superscript a is significantly different from superscript b, $p < 0.001$

(Figure 1). The soldiers working on the base guns drank significantly more fluid/day than those on the flank gun ($p < 0.05$) (Table 16).

Figure 1

Comparison of Fluid Sources During 8 Days of Sustained Field Operations

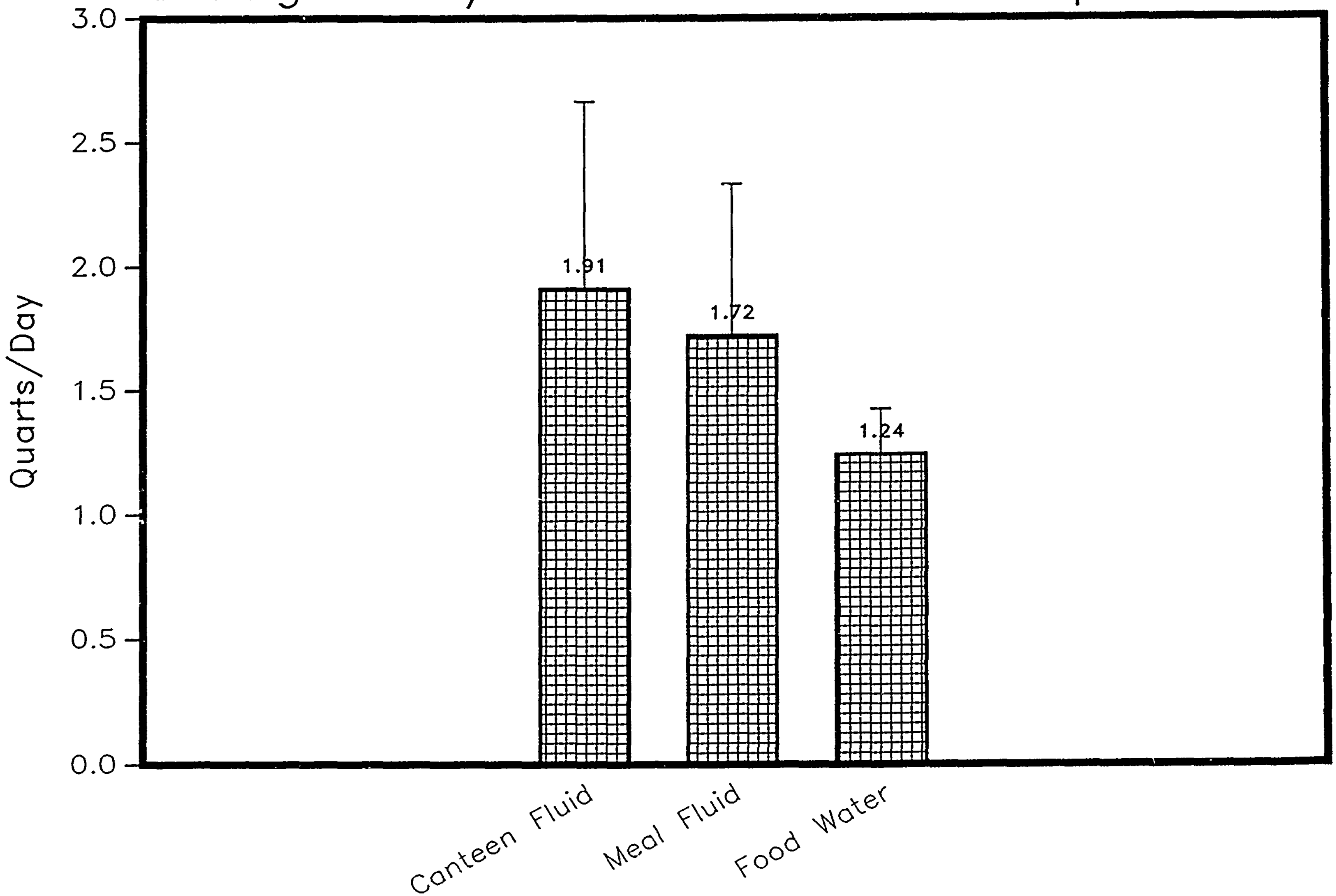

TABLE 16

FLUID INTAKE (QUARTS/DAY) BY GUN POSITION
DURING 8 DAYS OF SUSTAINED FIELD OPERATIONS

	BASE	FLANK	MEAN
n	167	80	247
Mean	5.13	4.50	4.93
SD	2.28	1.57	2.09

Base greater than Flank group ($p < 0.05$)

DISCUSSION

By consuming 3973 kcal, the soldiers in battery A consumed significantly more ($p < 0.001$) calories than those in batteries B and C (Table 7). Batteries A and C consumed more calories than the upper limit (3600 kcal) of the MRDA for moderate activity indicating a possibility for weight gain. The soldiers in battery A consumed the most calories but the soldiers in that battery weighed more than the soldiers in the other batteries. When caloric intakes are calculated per unit body weight, kcal/kg BW, the averages for the 3 batteries were not significantly different at 46.9, 44.3, and 47.2 kcal/kg BW (Table 8). The soldiers in each of the three batteries were consuming a proportional number of calories for their weight. A simplified method for calculating energy requirements uses 45 kcal/kg ideal BW to determine the energy needs of an active person (24). The soldiers in the present study would be considered active and consumed a similar number of kcal/kg BW.

Complete dietary data were collected from soldiers in the flank guns to determine if there were significant differences in energy intakes between soldiers manning the base pieces compared to those working on the flank pieces. The data showed that the soldiers on the base guns consumed significantly more ($p < 0.01$) calories but this was mainly due to differences in caloric intake in battery A (Table 9). The soldiers manning the base piece in battery A consumed about 600 kcal more than those working on the flank pieces. However, the soldiers on the base piece of battery A were about 9 kg heavier than those working on the flank guns. The extra calories consumed by the soldiers on the base piece could have been used to meet higher energy requirements due to their heavier weights or the extra calories could have been used to compensate for the extra work that the soldiers in the base piece were assigned. The energy intake for all the soldiers in the base pieces was greater than for the accompanying flank pieces but the weight gain was not significantly different (Table 12) suggesting that the base piece soldiers were more physically active.

A comparison of the present study in which the soldiers were eating 3 hot A-ration meals/day to previous studies (1,2) in which soldiers were offered 2 A-rations/1 MRE/day showed that more calories were consumed when 3 hot A-ration meals were served. The average number of calories consumed by the soldiers in the present study was 3713 kcal/day which was higher than the 2950 kcal/day for the Hirsch et al. (2) study and the 3271 kcal/day for the CFFS-FDTE (1) study. Receiving the third hot A-ration meal increased energy intake when compared to studies in which the combination of meals was 2 A-rations/1 MRE. In the CFFS-FDTE (1) study, the soldiers fed 2 A-rations/1 MRE consumed only 67% of the 1215 kcal available in the MRE meal. The major difference between the two studies was most likely due to soldiers eating more calories at noon when fed a hot A-ration meal compared to a MRE meal.

Rognum et al. (5) supplied 8000 kcal/day to one group of subjects and 1500 kcal/day to a second group. The group offered 8000 kcal/day lost 0.8% body weight in less than 5 days when theoretically they should have gained weight. The subjects in the CFFS-FDTE (1) study lost weight when offered 4679 kcal in a combination of 2 A-rations/1 MRE. The above studies showed that supplying an adequate number of calories does not necessarily ensure that subjects will consume enough food to maintain body weight. Other factors such as taste of the food and providing sufficient time to eat must also be considered.

Moderate exercise under temperate conditions decreases muscle glycogen about 56-84 mmol/kg in subjects (25,26). Costill et al. (22) showed that a diet containing 525 gm of carbohydrate in 3000 kcal would result in the synthesis of about 70 to 80 mmol/kg of muscle glycogen/24 hours. The present diet provided an average of 466 gm of carbohydrate in 3713 kcal which was probably insufficient to replenish the muscle glycogen stores of soldiers engaged in continuous moderate exercise. However, soldiers tend to restrict heavy physical work (> 50% VO_2 max) to short periods (9-12) during extended operations. Therefore, during the course of this sustained operations exercise the soldiers were probably operating at less than 50% VO_2 max so that fat would have been the predominant fuel and muscle glycogen would have been spared (13,19). The carbohydrate intake in the present study was probably sufficient to maintain muscle glycogen and not be a limiting factor to soldier performance. On the average about 94.8 g of the total amount of carbohydrate in the diet or 10.2% of the total calories was derived from sweetened beverage drinks. Intake of carbohydrate from this source ranged to a maximum of 47% of total calories for certain individuals. If a source of sweetened beverage drinks had been available between meals, the carbohydrate intake might have increased to higher levels.

As indicated in Table 1, the recommendation is that the dietary fat calories should not contribute more than 35% of the total energy intake. The amount of total fat consumed by soldiers in batteries A and B exceeded the recommendations but these values indicated a reduction in fat intake below the 40% that is normal for the general American public (27,28). The food as served by the garrison kitchen came very close to meeting the recommended maximum of 35% of the total energy intake. But, the pats of butter that were added to the food by individual soldiers increased the fat intake to greater than recommended levels. The MRDAs do not contain a recommendation for cholesterol intake but the amount ingested was greater than the latest recommendations by the American Heart Association of 300 mg/day (28). The mean intake ranged from 725 to 778 mg/day and these high intakes were mainly due to the consumption of eggs at breakfast. Other breakfast entrees such as pancakes, french toast, bacon, creamed ground beef, and ham were available at breakfast but were usually consumed in addition to eggs.

The soldiers were consuming more sodium than is recommended. The sodium intake ranged from 1793 to 2122 mg sodium/1000 kcal (Table 11); whereas, the OTSG recommendation for military food service systems is 1400-1700 mg sodium/1000 kcal (Appendix F). The salt that the soldiers added to their food caused their sodium intake to exceed recommended levels. The dining facility served food that was within the OTSG guidance for military food service systems. Most vegetables were cooked without added salt but canned vegetables were used a majority of the time. Entrees were generally prepared according to recipes but the cooks did use less than the suggested amount of salt in some recipes in accordance with the 1 Jan 86 DCSLOG policy to reduce the salt content of all Army recipes by 25% (Appendix H).

A significant difference in weight change occurred between the 3 batteries (Table 14) because the soldiers in battery B lost weight while those in batteries A and C gained weight but the maximum weight change for the soldiers in all three batteries was less than 1.9 kg or 4.18 lb. In previous studies (1,2,7,6,8-Vogel personal communication) the mean weight losses ranged from 0.8-5.8%. The present study differed from the previous studies in that subjects gained weight; they consumed more calories than in the previous studies; and weight was gained even though the subjects were participating in a sustained operations field exercise.

The soldiers in all 3 batteries drank a mean of 4.93 qts/day of fluid (Table 15) to meet the recommendations of the USARIEM Heat Research Division (Appendix G) on fluid needs for moderate work in a temperate environment. However, specific gravity measurements were not available to confirm the hydration status of the soldiers. Because the temperature was mild, it was possible that the troops were not hypohydrated. The average temperature for 8 days was 70°F with a range from 58-84°F (Appendix A). Only two 4-hour periods had temperatures of 80°F or higher. The soldiers in battery B consumed the least amount of fluid (4.24 qts/day) therefore there was a possibility that the body weight loss for battery B could be due to dehydration. For the soldiers in battery B the daily mean body weight change was usually less than 1 kg with a maximum weight loss of 0.8 kg (1.0%) on day 4 (Appendix E). This sharp one-day body weight loss occurred the day after the fewest calories (2752 kcal) were consumed during the entire study (Appendix D). The fluid intake of battery B was also lower (3.78 quarts) than the average on day 4. Researchers have recommended that body weight loss due to dehydration be restricted to less than 3% (29,30). A 3-4% loss in body weight could lead to a 20-30% drop in performance and a loss of greater than 5% could cause symptoms of heat exhaustion and heat stroke (31,32). Since the average body weight loss compared to the pre-test body weights did not exceed 3% body weight at any time during the study, hydration status probably did not affect the performance of the soldiers under these temperate conditions.

It is recognized that feeding 3 hot A-ration meals/day during field exercises is not practical. Under normal conditions of sustained operations, soldiers would be issued 3 MREs/day providing 3645 kcal/day. The soldiers in the present study maintained energy balance consuming 3713 kcal. Soldiers eating 3 MREs/day would have to consume 100% of their rations to maintain energy balance under the conditions of the present sustained operations study. Previous studies (1,2) have shown that soldiers will not eat all of the MREs. The CFFS-FDTE (1) and Hirsch et al. (2) studies showed that the soldiers would eat less than 2/3 of the total available calories when served 3 MREs/day. This level of energy consumption would result in a caloric deficit of about 1200 kcal/day which could lead to a 1.1 kg/week body weight loss. Therefore, providing 3 MREs/day would not ensure adequate consumption of calories to maintain energy balance and optimal muscle glycogen stores of soldiers involved in sustained operations exercises. The following are possible methods to increase available calories and the possibility that soldiers will consume a sufficient number of calories: (1) issue a fourth MRE to each soldier; (2) reformulate the MREs to include more calories per ration; or (3) provide a carbohydrate supplement (300 gm) in the form of beverage powders and/or candies. These changes would need to be tested to determine the most effective method of increasing caloric intake.

CONCLUSION

The present study showed that soldiers consuming 3 hot A-ration meals/day consumed 3713 kcal/day with an overall body weight gain of 0.8 kg during 8 days of sustained field operations. In previous field studies, body weight loss frequently occurred because of inadequate caloric consumption. In the present study the soldiers who were fed 3 A-ration meals/day consumed more calories than previously reported for soldiers fed 2 A-rations/1 MRE/day. The carbohydrate intake in the present study was probably sufficient to maintain muscle glycogen and should not have been a limiting factor to soldier performance. Three A-ration meals/day provided sufficient fluids to prevent dehydration in temperate weather conditions during moderate activity without the need to force canteen fluids. The fluid intake from food and from the fluid drunk at meals provided an average of 2.96 quarts of fluid. With the possible exception of B battery on day 4, the energy, carbohydrate, and fluid intakes were sufficiently adequate so that diet and hydration status should not have limited soldier performance during this 8-day sustained operations study.

Hot A-ration meals are more acceptable to soldiers than other types of current rations (T, B, MRE) as indicated by consumption data. The present study suggests that troops served hot meals that they like and given the opportunity to eat will consume enough food to maintain energy balance even during sustained operations. Permanently eliminating cooks and therefore the possibility of hot A-ration meals could contribute to soldiers losing body weight in the field unless the consumption rates of the current rations can be improved. Due to previously reported inadequate consumption rates, providing 3645 kcal in 3 MREs would not ensure adequate consumption of calories to maintain energy balance and optimal muscle glycogen stores of soldiers involved in sustained operations exercises.

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APPENDIX A

FORT SILL WEATHER

Day 1	Temp°	Humidity %
1200	75	83
1600	77	38
2000	72	37
Day 2		
0001	73	54
0400	70	58
0800	60	86
1200	60	62
1600	67	46
2000	75	58
Day 3		
0001	68	73
0400	58	77
0800	71	81
1200	75	86
1600	70	64
2000	60	68
Day 4 rain		
0001	67	73
0400	64	94
0800	65	92
1200	65	97
1600	68	88
2000	77	67
Day 5		
0001	71	97
0400	65	83
0800	68	85
1200	76	86
1600	75	76
2000	77	87
Day 6		
0001	68	81
0400	63	79
0800	66	81
1200	69	60
1600	79	60
2000	84	57

Fort Sill Weather (continued)

Day 7	rain	Temp°	Humidity %	
0001		73	93	
0400		70	97	
0800		70	100	rain
1200		69	97	
1600		80	80	
2000		79	75	
Day 8	rain			
0001		78	80	
0400		71	97	
0800		69	92	
1200		75	87	
1600		70	90	
2000		70	99	
Day 9				
0001		68	98	
0400		68	97	

APPENDIX B

A-RATION MENU DURING 8 DAYS OF SUSTAINED FIELD OPERATIONS

BREAKFAST

28 May	29 May	30 May	31 May	1 Jun	2 Jun	3 Jun	4 Jun	5 Jun
	Orange Jce	Grape Jce	Sausage	Scr Eggs	Crm Beef	P/A Juice	Juice	Grape Jce
	Apple, fr	Orange, fr	Scr Eggs	Bacon	Scr Eggs	Scr Eggs	Orange, fr	Orange/Apple
	Grits	Oatmeal	Grits	Oatmeal	Grits	Apple, fr	Apple, fr	Hashed Pot
	Scr Eggs	Scr Eggs	Hashed Pot	Hashed Pot	Pancakes	Oatmeal	Grits	Oatmeal
	Sausage	Bacon	Pancakes	Pancakes	Hashed Pot	Hashed Pot	Scr Eggs	Scr Eggs
	Hashed Pot	Fr Toast	Apple/Orange	Pear, fr	Orange Jce	Sausage	Bacon	Crm Beef
	Pancakes	Toast	Biscuits	Orange, fr		Pancakes	Pancakes	Pancakes
	Toast	Hashed Pot	Orange Jce	Orange Jce			Hashed Pot	Biscuits

Available at every breakfast: Syrup, Asst Jelly.

LUNCH

28 May	29 May	30 May	31 May	1 Jun	2 Jun	3 Jun	4 Jun	5 Jun
Bkd Ham	Salisbury Stk	Sp Beef Pat	Chili Mac	Polish Saus/	Spag/Mt Sce	Salisbury Stk	Polish Sausage	
Rissole Pot	Smoth'd Stk	Baked Beans	Corn	Salisbury Stk	Parmesan Chs	Brn Gravy	Grl Onions	
Corn	Brn Gravy	Wax Beans	Green Salad	Bkd Beans	Mixed Veg	Fried Rice	Bkd Beans	
Green Salad	Boiled Pot	Coleslaw	Pear, fr	Grn Beans	Cookies	Lima Beans	Ckd Carrots	
Cnd Peaches	Lima Beans	Cookies		Green Salad	Green Salad	Green Salad	Green Salad	
	Green Salad	Rye Brd		Cnd Peaches		Cookies	Frt Cocktail	
	Yellow Cake							
	Bu Crm Frost							

Available at every lunch and dinner: Koolade, Asst Regular and Low Calorie Salad Dressings, Mustard.

DINNER

28 May	29 May	30 May	31 May	1 Jun	2 Jun	3 Jun	4 Jun	5 Jun
Tom Veg Sp	Rst Turkey	Fried Chix	Chix Soup	Bkd Chix	Rst Pork	Grl Steak/On	Pork Chops	
Smoth Steak	Gravy	Gravy	Rst Beef	Brn Gravy	Gr Beans	Brn Gvy/Stk Sc	Brn Gravy	
Brn Gravy	CranberrySce	Msh Pot	Brn Gravy	Crm Corn	Swt Potatoes	Corn	Green Beans	
Msh Pot	Msh Pot	Mixed Veg	Ckd Carrots	Msh Potato	Green Salad	Msh Potato	Can Swt Pot	
BlackeyePeas	Mixed Veg	Green Salad	Msh Pot	Green Salad	Devil Fd Ck	Green Salad	Green Salad	
Green Salad	Cornbrd Drsg	Brownies	Green Salad	Devil Fd Ck	Bu Crm Frost	Yellow Cake/	Yellow Cake	
Devil Fd Ck	Green Salad		Marble Cake	Bu Crm Frost	Brn Gravy	Bu Crm Frost/	Bu Crm Frost	
Bu Crm Frost	Cookies		Bu Crm Frost			Cookies		

Available at every meal: White Bread, Whole Wheat Bread, butter, salt (1 gm packet), pepper, sugar, coffee, Choc Milk, 2% Milk, Tabasco Sauce, Catsup, Cream Sub.

APPENDIX C

RATION RECORD

NAME: ____________________ DATA COLLECTOR # __________

SUBJECT #: ____________________ DATA ENTERER # __________

JULIAN DATE: 85__________

MEAL: (CIRCLE ONE) RATION TYPE: (CIRCLE ONE)

BREAKFAST - B   A   B   T

DINNER - D

FOOD TYPE	DESCRIPTION	CODE #	REASON NOT EATEN CODE	PORTION SERVED	PORTION RETURNED	RATING CODE
ENTREE						
VEGETABLE						
STARCH						
FRUIT						
BREAD						
SPREAD						
DESSERT						
BEVERAGE						
OTHER						

NATICK Form 613 (ONE-TIME)
1 Jul 85

APPENDIX D

DAILY ENERGY INTAKE DURING 8 DAYS OF SUSTAINED FIELD OPERATIONS

DAY	BATTERIES A (n=11)	B (n=9)	C (n=11)
1	3160±582	3195±364	3231±424
2	4246±771	3474±382	3742±410
3	3964±826	3604±398	3615±487
4	2983±397	2752±316	3097±520
5	4405±610	3165±741	3888±496
6	3869±824	3677±602	3908±502
7	4884±1210	3713±525	3820±549
8	4273±930	4151±721	3930±710

APPENDIX E

DAILY BODY WEIGHTS (kg)

DATE	BATTERIES A (n=11)	B (n=9)	C (n=11)
5/28/86	82.8±15.2[a]	No data	77.4±10.1
5/29/86	83.0±14.9	80.6±8.0	77.6±10.0
5/30/86	83.2±14.9	80.1±7.9	78.1±10.2
5/31/86	82.1±14.9	80.2±7.7	78.2±9.9
6/1/86	82.9±15.0	79.4±8.1	78.6±10.4
6/2/86	82.7±15.2	80.1±7.9	77.9±10.2
6/3/86	No data	No data	No data
6/4/86	83.2±15.2	79.8±7.7	77.8±10.2
6/5/86	83.8±15.9	79.9±7.8	79.3±9.9

APPENDIX F

DEPARTMENT OF THE ARMY
OFFICE OF THE SURGEON GENERAL
WASHINGTON, D.C. 20310-2300

REPLY TO
ATTENTION OF

DASG-DBD

19 JUN 1986

SUBJECT: Sodium Content in Rations

THRU: The Deputy Chief of Staff for Logistics
Department of the Army
Washington, D.C. 20310-0564

TO: Commander
U.S. Army Troop Support Agency
Fort Lee, Virginia 23801-5260

1. With the Army's move to promote the consumption of a more healthful diet, many nutrition initiatives have been implemented in garrison dining facilities. Results from the 1985 Hawaii Combat Field Feeding System (CFFS) Test also provided data for making improvements in operational rations. These improvements were greatly needed and will benefit every soldier.

2. In recent briefings on the CFFS test results, questions were raised regarding OTSG recommendations for the appropriate amount of sodium in operational rations and in food served in garrison dining facilities. By AR 40-25 (Nutrition Allowances, Standards and Education), we provided a target of 1700 milligrams (mg) sodium per 1000 kilocalories (kcal). To remove uncertainty as to whether the target is an upper or lower limit, we are restating our guidance as an acceptable range of 1400-1700 mg sodium per 1000 kcal for garrison feeding. This equates to a range of 4200-5100 mg sodium per day for light-to-moderately active male soldiers consuming 3000 kcal/day. It also equates to a range of 2800-3400 mg sodium per day for female soldiers consuming 2000 kcal/day. Certain soldiers may choose to add discretionary table salt. However, this additional salt is not needed and should be discouraged through nutrition education efforts and offering alternative low sodium seasonings.

3. At MG Honor's request, researchers at the U.S. Army Research Institute of Environmental Medicine (USARIEM), are initiating two nutrition research projects. The first will commence this summer and will measure actual nutrient (including sodium) consumption of soldiers at one or more Enlisted Dining Facilities (EDF). This will provide, for the first time, an initial data base to

evaluate the effectiveness of nutrition initiatives. The second effort will specifically address the soldier's sodium requirements in a variety of climates. This will support further OTSG recommendations on the sodium content of rations.

4. I sincerely hope this information has been helpful and will assist your staff in their efforts. The OTSG POC is COL Martha Cronin, Chief Dietitian Section, OTSG, AV 289-0066. If we can be of further assistance, please feel free to call.

Robert H. Buker M.D.
ROBERT H. BUKER
Brigadier General, MC
Acting The Surgeon General

APPENDIX G

Individual Drinking Water Guidance*

Force Factors		Environmental Conditions		
Work Rate[1]	Percent Working	Temperate[2] 32-80°F	Hot >80°F	Cold <32°F
		Qts Per Man Per Working Day[3]		
Light	15%	3	8	5
Moderate	65%	5	11	7
Heavy (Sustainable)	20%	8	14	10[4]
Heavy (Maximum)		14	20	16
Planning Factors		6	12[5]	8

[1] MOPP 3 or 4 are considered heavy work.

[2] Mean Daily Temperature

[3] 12 h work day

[4] 6h limit for sustained effort in arctic clothing

[5] IDF planning factor for hot regions is 16 qts.

* Volumes of water contributed by ration food and beverages:
2 hot meals and 1 MRE = 1.5 qt
1 hot meal and 2 MRE = 1.0 qt
3 MRE's = 0.5 qt

Modified by Heat Research Division, US Army Research Institute of Environmental Medicine, Natick, MA from Water Consumption Planning Factors Study by Directorate of Combat Developments, US Army Quartermaster School, Fort Lee, VA 23801, ACN82888, 1 July 1983.

APPENDIX H

DEPARTMENT OF THE ARMY
OFFICE OF THE DEPUTY CHIEF OF STAFF FOR LOGISTICS
WASHINGTON, D C 20310-05

8 [illegible] 198[illegible]

DALO-TST 8650721L

LTG Register DCSLOG 54102

MEMORANDUM THRU ~~DEPUTY CHIEF OF STAFF FOR LOGISTICS~~ 9/9
DIRECTOR OF THE ARMY STAFF

FOR VICE CHIEF OF STAFF, ARMY

SUBJECT: Update of Army Nutrition Initiatives--INFORMATION MEMORANDUM

1. This memorandum provides additional information, based on your request at Natick, on our progress to reduce "heart threatening ingredients" in recipes and menus.

2. Salt Reduction.

a. Armed Forces Recipes. The recipes have been revised in two phases to meet OTSG Nutrition Standards. A 25 percent across-the-board reduction of table salt used in recipes was directed in January 1986 by ODCSLOG and OTSG as an interim measure. Changes 1, 2 and 3 and the NRDEC contract complete the revision process to reduce levels of total sodium. Change 1 was distributed in August 1985 and is in use in our dining facilities; Change 2 is currently being printed. Change 3 and the contract recipes are scheduled for printing in FY87.

b. Army Master Menu. Since 1984, the nondiscretionary sodium level in the Master Menu has been reduced from 6900 milligrams per day to 5300 milligrams per day in the 1986 menu. This level is consistent with the range of 1400-1700 milligrams per 1000 calories of food served, recommended by the Surgeon General and the Military Nutrition Committee of the National Academy of Sciences.

3. Fat Reduction. The calories from fat sources in the Master Menu have been reduced from 40 percent of calories in the 1984 menu to 36 percent in the 1986 menu. Further reductions in the fat content of the 1987 menu will meet the Surgeon General's recommended 35 percent fat level. At enclosure is a chart which depicts the progress made in achieving fat and sodium reductions in the Master Menu since 1984. The initiative to reduce fat intake by implementing lowfat milk as the primary milk source has received high troop acceptability. Currently, 101 of 120 installations are serving lowfat milk. Over twenty of these

DALO-TST
SUBJECT: Update of Army Nutrition Initiatives--INFORMATION MEMORANDUM

installations, on their own initiative, have eliminated whole milk from the menu. We still have a goal of 100 percent implementation of lowfat milk by the end of the fiscal year.

4. Evaluation of Sodium and Fat Initiatives. The U.S. Army Research Institute for Environmental Medicine (USARIEM) is assisting us in evaluating the effect of our initiatives to lower sodium and fat by measuring soldiers' actual intakes of sodium, fat and other nutrients during meal periods in the dining facility. The first of four such studies was completed in August at the NCO Academy at Fort Riley, Kansas. USARIEM will be prepared to brief you on the results of the test in approximately 60 days and at the end of the fourth study in late FY87.

SIGNED

Encl

EDWARD HONOR
Major General, GS
Director for Transportation,
Energy and Troop Support

Mrs. Adolphi/51201
Typed by Mrs. Bleakley

2

ARMY MASTER MENU NUTRIENT REDUCTION ACHIEVEMENTS

YEAR	NON-DISCRETIONARY SODIUM (MILLIGRAMS/DAY)	PERCENT OF CALORIES FROM FAT
1984	6900	40.0
1985	6400	37.5
1986	5300	36.0
1987	5300	35.0
AR40-25 STANDARDS	5500 (MALES)* 4100 (FEMALES)*	35.0

* 1400-1700 MILLIGRAMS/1000 CALORIES OF FOOD SERVED

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